Fisheries and Oceans Canada
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Gulf Region

Canadian Science Advisory Secretariat
Science Response 2014/028

UPDATED INDICES OF ABUNDANCE TO 2013 FOR STOCKS OF SIX GROUNDFISH SPECIES ASSESSED BY DFO GULF REGION

Context

DFO has conducted research vessel (RV) surveys in the southern Gulf of St. Lawrence, Northwest Atlantic Fisheries Organization (NAFO) Area 4T (Figure 1) using standardized protocols each September since 1971. In addition, two sentinel programs, a sentinel longline program conducted since 1995 and an otter trawl survey conducted each August since 2003, have been conducted by DFO in collaboration with the fishing industry. Results of these surveys provide information on trends in abundance and biomass for groundfish species in the 4T area. While these data reflect trends in biomass and abundance and are a critical part of science-based stock assessments, a full assessment, including other sources of data, would be required to evaluate the impacts of management measures on population status. Fisheries and Aquaculture Management (FAM) requested a review of the DFO survey information on the following species in NAFO Area 4T: Atlantic cod, American plaice, white hake, winter flounder, and yellowtail flounder. In addition, information on witch flounder in the 4RST area (northern and southern Gulf of St. Lawrence) was requested by FAM. For this stock, data from RV and sentinel surveys of the southern Gulf were combined with data from similar surveys conducted in the northern Gulf to construct survey indices. This survey information will be communicated by FAM to the various industry stakeholders for the intervening years of the multi-year management plan. The information may also be used to determine which stocks may benefit from a detailed review in future years. This Science Response Report results from the Science Response Process of February 28, 2014, on the review of indices of abundance to 2013 for stocks of six groundfish species assessed by DFO Gulf Region. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Background

The six species and stocks covered by this report are under commercial fishery moratorium or have small annual Total Allowable Catches (TAC) (Table 1).

Table 1. Groundfish species and stocks addressed in this report and the total allowable catch in 2013 for each species.

Species and stock	Total allowable catch in 2013
Atlantic cod (*Gadus morhua*) 4T-4Vn(Nov-April)	300 t (no directed commercial fishery)[1]
American plaice (*Hippoglossoides platessoides*) 4T	250 t
White hake (*Urophycis tenuis*) 4T	30 t (no directed commercial fishery)[1]
Winter flounder (*Pseudopleuronectes americanus*) 4T	300 t
Yellowtail flounder (*Limanda ferruginea*) 4T	300 t
Witch flounder (*Glyptocephalus cynoglossus*) 4RST	300 t

[1] *to cover by-catch in other groundfish fisheries; a limited recreational fishery, scientific purposes, and in the case of cod, negotiated Aboriginal food, social and ceremonial agreements*

The September RV survey of the southern Gulf of St. Lawrence follows a stratified random sampling design (Figure 1), and includes sampling of fish and invertebrates using a bottom otter trawl. This survey, conducted annually since 1971, is the primary data source for monitoring trends in species distribution, abundance, and biological characteristics (e.g., size and age composition, growth) in the southern Gulf of St. Lawrence (for details see Savoie 2014a). The same stratification scheme has been used since 1971, except for the addition of three inshore strata (401-403) in 1984. Unless otherwise stated, the analyses presented here are based on the 24 strata (415-439) sampled since 1971. Comparative fishing experiments were conducted to test for changes in fishing efficiency whenever there was a change in research vessel (1985, 1992, and 2004/2005), trawl gear (1985) or survey protocol (i.e., a change from day only to 24-hr fishing in 1985). When a change in fishing efficiency was detected for a particular species, catch rates of that species were standardized to constant level of efficiency so that indices remained comparable for the entire time series (Benoît and Swain 2003; Benoît 2006).

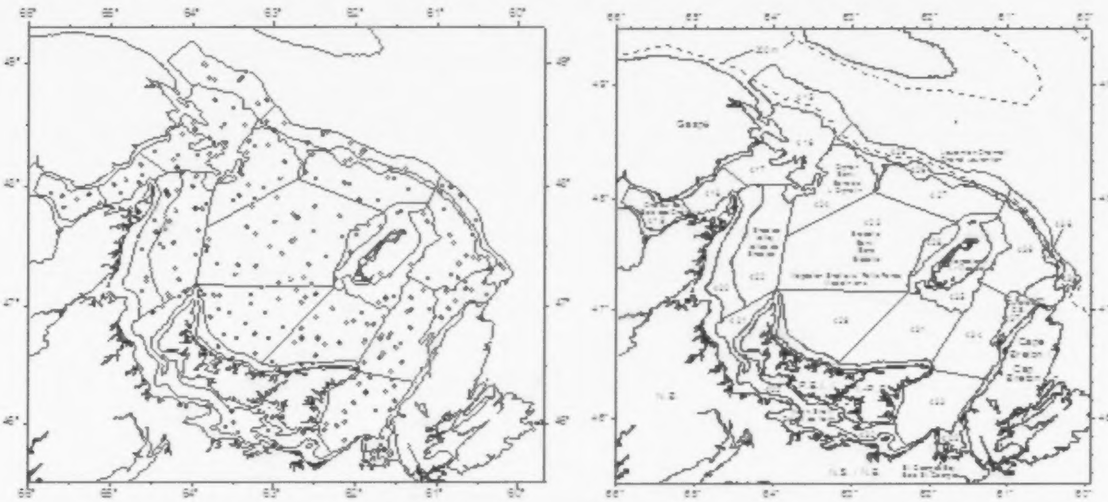

Figure 1. Location of fishing sets in the 2012 (gray) and 2013 (black) RV surveys(left panel) and the stratification scheme for the southern Gulf of St. Lawrence (right panel).

The RV survey was designed to provide abundance trends for fish and invertebrates distributed between depths of about 20 m and 350 m. Survey indices are expected to be proportional to abundance for most species. The distributions of some species, such as winter flounder which is a coastal species, are not fully covered by the survey. Abundance trends for these species may only provide an indication of the direction of change over time.

The sentinel bottom-trawl survey, conducted each August since 2003, uses the same stratified random design as the RV survey (Figure 1). The survey is conducted using four commercial vessels each year, using the same fishing gear and standardized protocols. For widely distributed species (Atlantic cod and American plaice), abundance and biomass indices have been standardized for any differences in fishing efficiency between vessels. This is not possible for species with more restricted distributions. See Savoie (2014b) for further details.

The sentinel longline program for the southern Gulf of St. Lawrence provides an index for cod (Savoie 2014c). Fishing is conducted at fixed sites in near-shore areas distributed throughout the southern Gulf. Each site was fished several times a year in the July – October period. A standardized annual index of catch rates of cod was obtained from 1995 to 2013 using a statistical analysis that accounted for differences in catch rates between months and sites.

Analysis and Response

Indicators of the stock by species

Atlantic cod

The last full assessment of the Atlantic cod stock in the southern Gulf of St. Lawrence was conducted in February 2009 using data from 2008 and earlier (DFO 2009; Swain et al. 2009). In addition, a Recovery Potential Assessment (RPA) was conducted in February 2011 using data from 2009 and earlier (DFO 2011a; Swain et al. 2012a). Both these analyses led to the conclusion that adult biomass in this stock was at the lowest level observed in the 60-year record and well below the limit reference point (LRP) for this stock, the level below which the stock is considered to have suffered serious harm to its productivity. The directed fishery for southern Gulf cod was closed in 1994-1997, 2003, and since 2009.

The RV survey biomass index for cod of pre-commercial lengths was at the lowest level observed in the 40-year time series in 2010-2012 (Figure 2a). The index in 2013 was at a higher level, comparable to the levels observed in 2002 and 2009. Uncertainty in the index was high in these years, and the relatively high index in 2009 was not reflected in subsequent increases in biomass at larger sizes.

The RV biomass index for commercial-sized cod has been at a low level since the early 1990s (Figure 2b). The index declined from the early 2000s to the lowest levels observed in the 43-yr time series in 2011 and 2012. The index remained near this record low level in 2013.

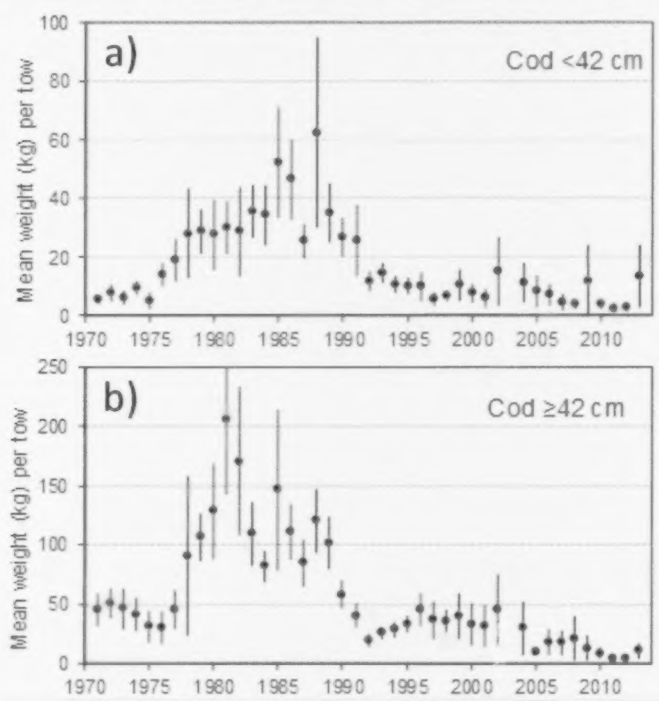

Figure 2. RV survey biomass indices for Atlantic cod of pre-commercial (a) and commercial (b) lengths. These size classes correspond approximately to juvenile and adult cod. Vertical lines denote approximate 95% confidence limits (± 2 standard errors).

The biomass index for cod from the sentinel bottom-trawl survey has declined over the 11-year time series (Figure 3). The 2012 and 2013 values are the lowest in the time series. The cod biomass index from the sentinel longline program declined each year from 2005 to 2011, setting a new record each year for the lowest level on record (Figure 4). No further declines in the index occurred in 2012 and 2013, though the values in these years remained near the record-low 2011 value.

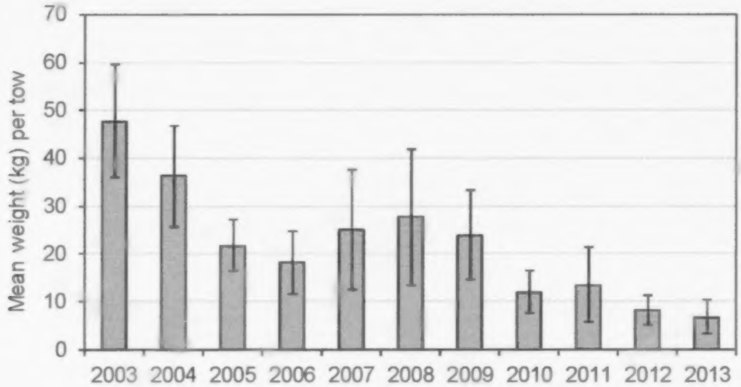

Figure 3. Biomass index for Atlantic cod (all sizes) from the sentinel bottom-trawl survey. Vertical lines denote approximate 95% confidence limits. The indices have been standardized for differences in fishing efficiency between vessels.

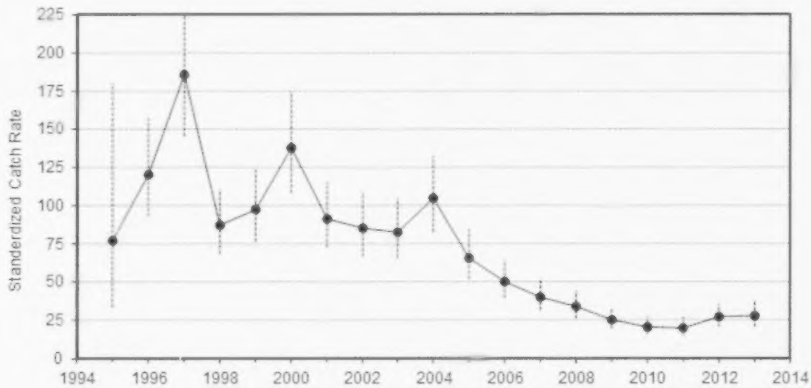

Figure 4. Standardized catch rate (kg/1000 hooks) for Atlantic cod (all sizes) from the sentinel longline program. Vertical lines denote approximate 95% confidence limits.

American plaice

The status of American plaice in the southern Gulf of St. Lawrence was last reviewed in February 2012 as part of a Recovery Potential Assessment and when the LRP for this stock was established (DFO 2011b; DFO 2012c; Morin and LeBlanc 2012; Morin et al. 2013).That review, using data to 2011, concluded that the 4T stock of American plaice was at an all-time low level of abundance and had been below the LRP since 1997 (except in 2004).

The RV survey biomass index for pre-commercial sizes of American plaice declined steadily from 1991 to 1999 and has remained at a record low level since then (Figure 5a). The biomass index for commercial sizes shows the same pattern (Figure 5b). The biomass index for plaice

from the sentinel bottom-trawl survey has declined since the start of the time series in 2003 (Figure 6). The 2013 value is the lowest in the time series.

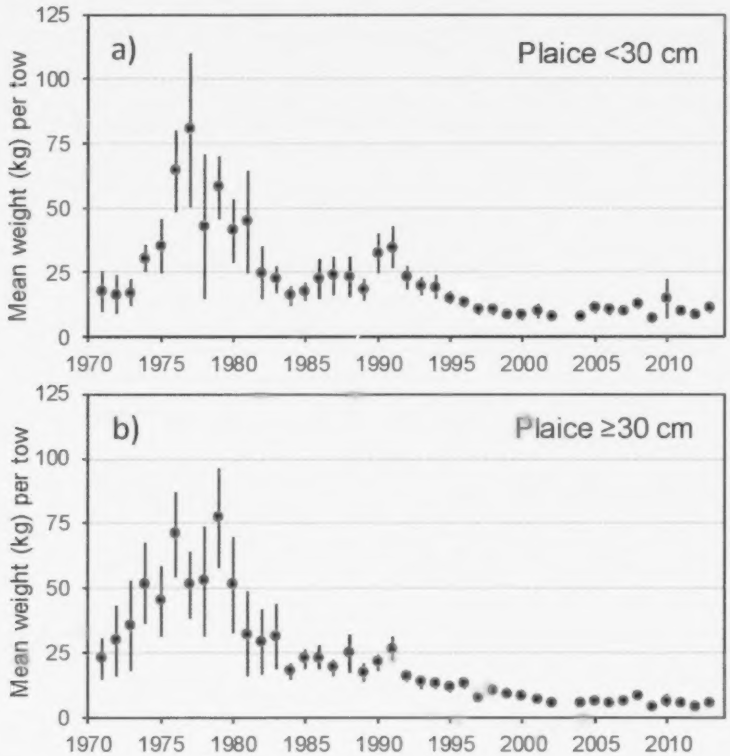

Figure 5. RV survey biomass indices for American plaice of pre-commercial (a) and commercial (b) lengths. Vertical lines denote approximate 95% confidence limits.

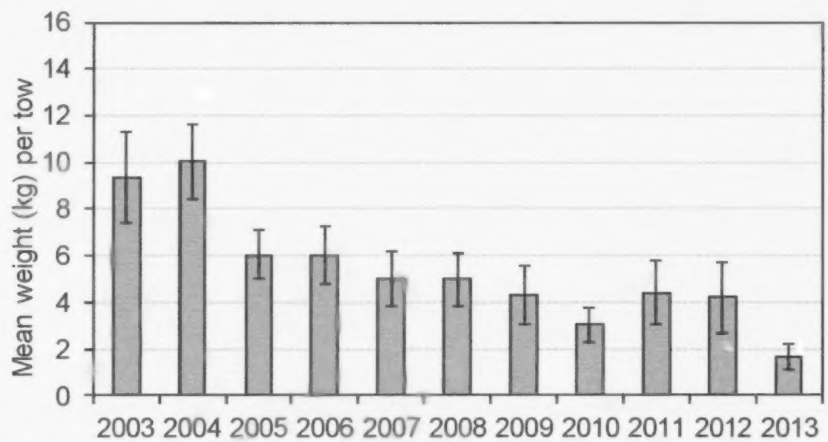

Figure 6. Biomass index for American plaice (all sizes) from the sentinel bottom-trawl survey. Vertical lines denote approximate 95% confidence limits. The indices have been standardized for differences in fishing efficiency between vessels.

White hake

The last full assessment of the 4T white hake stock was conducted in 2001 (DFO 2001; Hurlbut and Poirier 2001). Survey data on this resource were updated to 2002 (DFO 2005a) and in a review of information on the status of this stock (Swain et al. 2012b) in preparation for the assessment of white hake by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The pre-COSEWIC review reported that there had been an 80-90% decline in the abundance of mature fish in this stock over the past three generations (i.e., between 1984 and 2010) and that there had been no recovery of this resource despite a moratorium on the directed fishery since 1995.

The RV survey biomass index for commercial-sized white hake declined sharply between the mid-1980s and mid-1990s, and has been at a very low level since then (Figure 7b). The biomass index for pre-commercial sizes has been relatively low in most years since 1993 (Figure 7a), though the decline in the index for these small sizes was not as sharp as the decline at larger sizes. Biomass at pre-commercial sizes was at about the same level in 2012 as in 2008-2011, but in 2013 was at the lowest level observed.

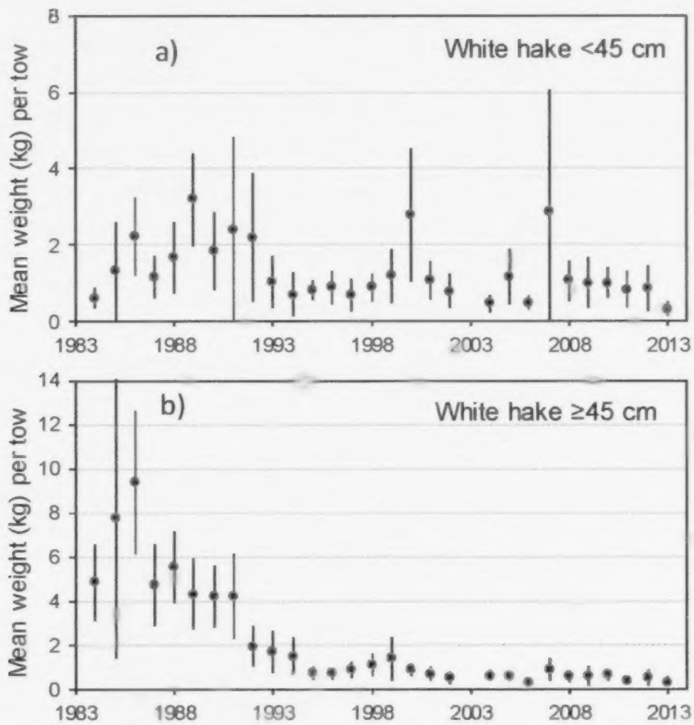

Figure 7. RV survey biomass indices for white hake of pre-commercial (a) and commercial (b) lengths. Vertical lines denote approximate 95% confidence limits. Indices are based on strata 401 and 403 in addition to the standard strata 415-439; hence the indices begin in 1984 instead of 1971.

The white hake biomass index from the sentinel bottom-trawl survey declined from the start of the series to the lowest values in 2012 and 2013 (Figure 8).

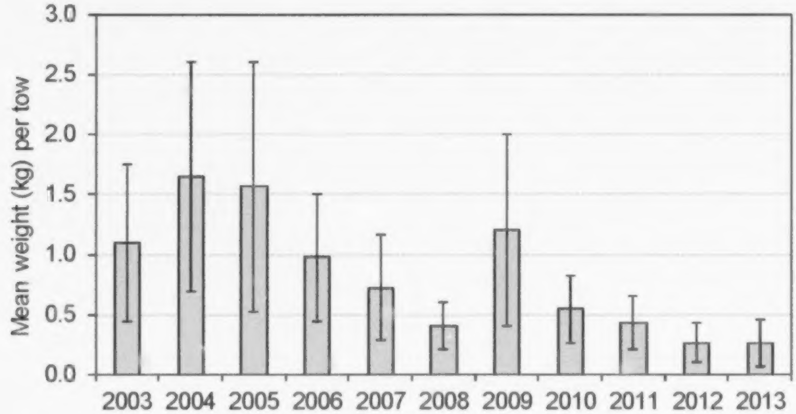

Figure 8. Biomass index for white hake (all sizes) from the sentinel bottom-trawl survey. Vertical lines denote approximate 95% confidence limits. The indices have not been standardized for differences in fishing efficiency between vessels.

Winter flounder

Winter flounder in NAFO area 4T was last assessed in 2012 using data up to 2011 (DFO 2012a; Morin et al. 2012). The 2012 assessment reported that the survey biomass index for winter flounder had declined to the lowest level on record in 2011.

The RV survey biomass index for winter flounder of pre-commercial lengths was at an intermediate level from 1993 to 2010 (Figure 9a). This index declined to a low level in 2011 and remained at that low level in 2012 and 2013. The biomass index for commercial sizes has been in decline since the early 1990s (Figure 9b). In 2011, the index was at the lowest level observed. The index remained at this low level in 2012 and 2013.

The biomass index for winter flounder from the sentinel bottom-trawl survey has declined since the start of the survey in 2003 (Figure 10). This index was at the lowest levels on record in 2012 and 2013, averaging 3% of the 2003 value in these two years.

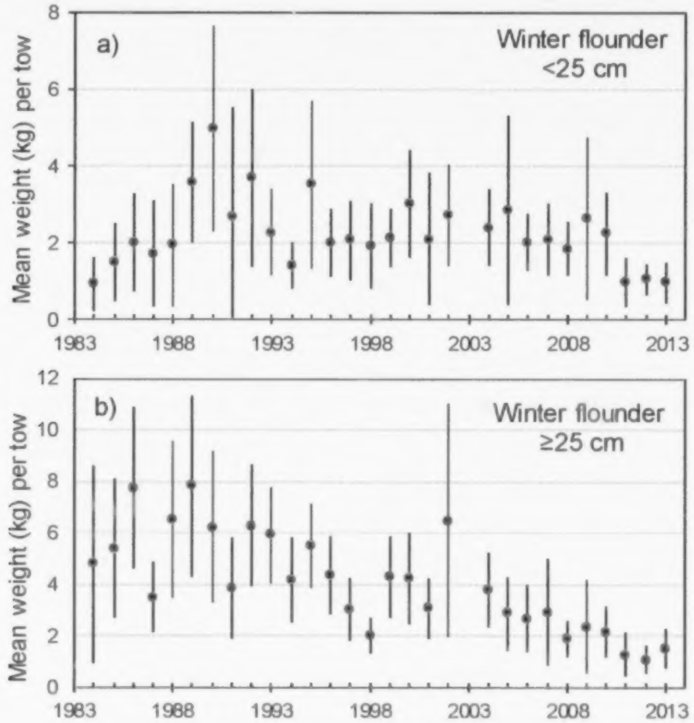

Figure 9. RV survey biomass indices for winter flounder of pre-commercial (a) and commercial (b) lengths. Vertical lines denote approximate 95% confidence limits. Indices are based on strata 401-403 in addition to the standard strata 415-439; hence the indices begin in 1984 instead of 1971.

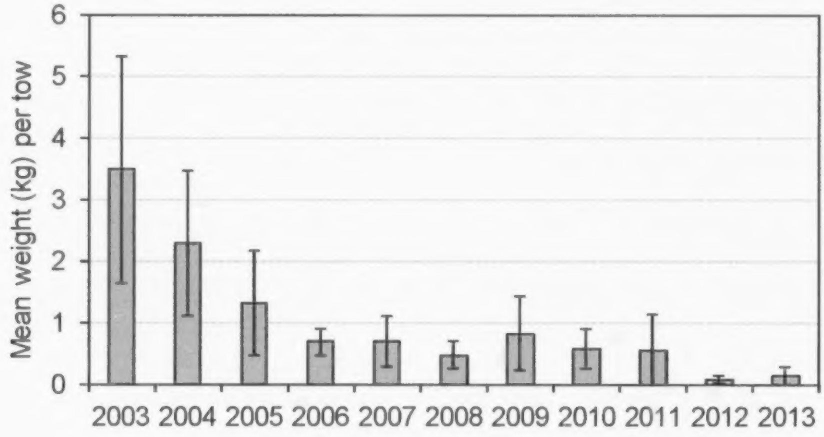

Figure 10. Biomass index for winter flounder (all sizes) from the sentinel bottom-trawl survey. Vertical lines denote approximate 95% confidence limits. The indices have not been standardized for differences in fishing efficiency between vessels.

Yellowtail flounder

The last full assessment of 4T yellowtail flounder was conducted in 2002 and used data from 2001 and earlier (DFO 2002; Poirier and Morin 2002). The RV survey abundance index was

reported to have remained relatively stable from 1985 to 2001 over the whole 4T area. In the strata surrounding the Magdalen Islands, where the main fishery for yellowtail occurred, the abundance index increased from 1985 to 1993 and remained relatively stable from 1993 to 2001. A large reported commercial catch of 800 t in 1997 appeared to result in a decline in the modal size of yellowtail in the RV survey catches. It was suggested that the stock appears able to support harvest levels closer to 300 t. An update was provided in 2005 (DFO 2005b) and a review of size at maturity and size characteristics of the catches in the fishery in the Magdalen Islands was conducted in 2010 (DFO 2010).

The RV survey biomass index for pre-commercial sized yellowtail flounder increased greatly from the mid-1980s to the mid-2000s and then levelled off (Figure 11a). In contrast, the biomass index for commercial-sized yellowtail decreased sharply from the mid-1990s to the present (Figure 11b). The commercial biomass index has been at record-low levels since 2008. Similarly, the biomass index for yellowtail from the sentinel bottom-trawl survey decreased over the 2003-2013 time series, with the value in 2013 the lowest on record (Figure 12).

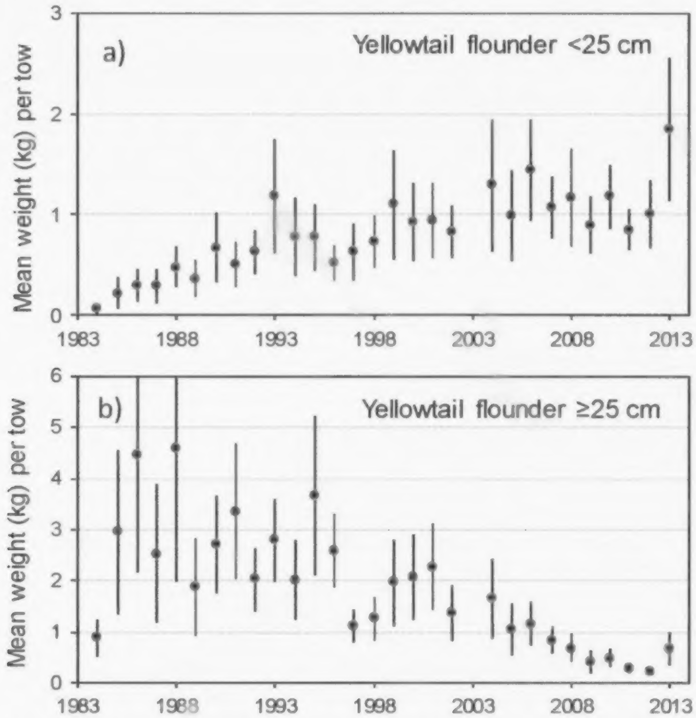

Figure 11. RV survey biomass indices for yellowtail flounder of pre-commercial (a) and commercial (b) lengths. Vertical lines denote approximate 95% confidence limits. Indices are based on strata 401-403 in addition to the standard strata 415-439; hence the indices begin in 1984 instead of 1971.

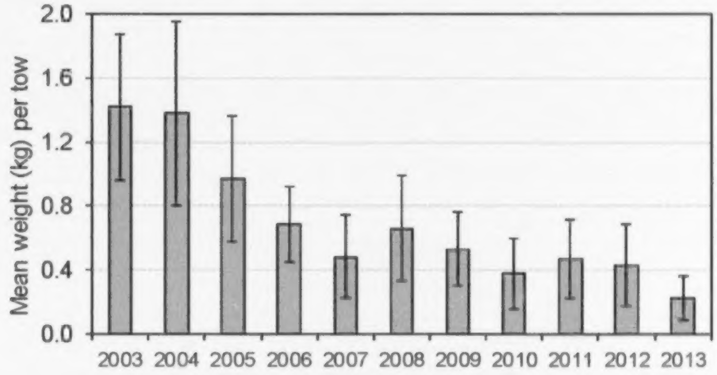

Figure 12. Biomass index for yellowtail flounder (all sizes) from the sentinel bottom-trawl survey. Vertical lines denote approximate 95% confidence limits. The indices have not been standardized for differences in fishing efficiency between vessels.

The main fishery for yellowtail flounder occurs in the waters off the Magdalen Islands. The RV survey biomass indices for yellowtail in the strata surrounding the Magdalen Islands are shown in Figure 13. Like in the 4T area as a whole, biomass at pre-commercial sizes increased sharply from the late 1980s to the mid-2000s in the area around the Magdalen Islands whereas biomass at commercial sizes dropped sharply between the mid-1990s and late 2000s in this area. Commercial biomass has been at the lowest level observed since 2007.

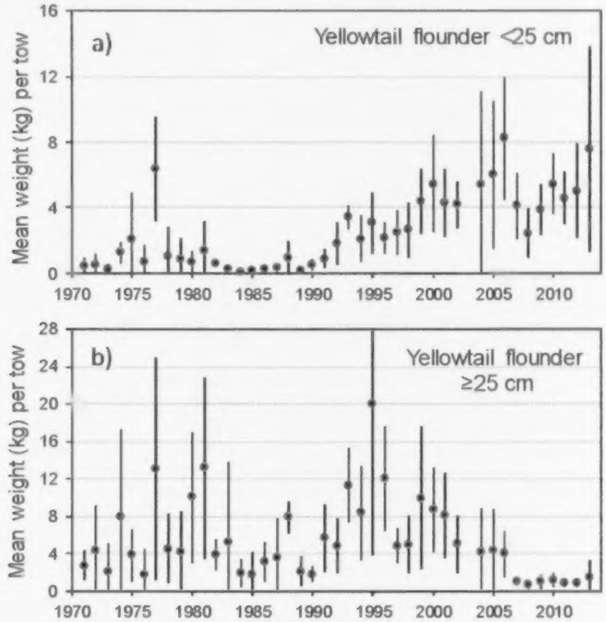

Figure 13. RV survey biomass indices for yellowtail flounder of pre-commercial (a) and commercial (b) lengths in strata 428 and 434-436 (the strata surrounding the Magdalen Islands). Vertical lines denote approximate 95% confidence limits.

Witch Flounder

Unlike the other stocks reviewed here, the management unit for witch flounder is NAFO area 4RST, corresponding to the entire Gulf of St. Lawrence. Biomass indices are constructed for this stock by combining data from the September RV survey of the southern Gulf and the August RV survey of the northern Gulf (Swain et al. 2012c). Based on the results of comparative fishing experiments, catch rates are standardized to account for any differences in fishing efficiency between the different vessels and gears that have been used to conduct these surveys. Because some of these adjustments are length dependent, the combined index is available only since 1987, the first year in which length frequency information is available for witch flounder in the August survey. Similarly, a combined sentinel survey index is constructed using data from the August sentinel bottom-trawl survey of the southern Gulf and the July sentinel survey of the northern Gulf. The same gear is used in these two surveys, except that a restrictor cable is used in the July survey but not the August survey. This combined index is available since 2003, the first year that the August sentinel survey was conducted.

The last assessment of the 4RST witch flounder stock was conducted in February 2012 using data to 2011 (DFO 2012b; Swain et al. 2012c). A population model fit to fishery catch and survey biomass indices indicated a 90% decline in commercial biomass since 1961, with biomass in 2011 estimated to be about half of the LRP. However, survey length distributions indicated that a strong year-class was approaching commercial sizes and may promote rebuilding of the stock if catches were kept low.

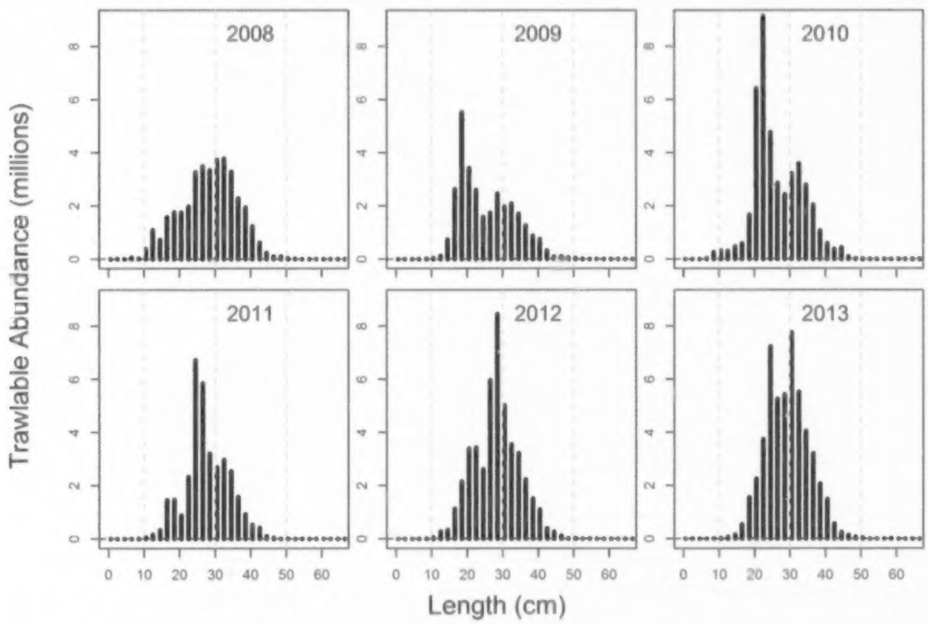

Figure 14. Length distributions of witch flounder in RV survey catches in 2008-2013.

Catches in the 2012 and 2013 RV surveys indicate that the strong year-class observed in the 2009-2011 surveys is now recruiting to commercial sizes (Figure 14). The RV biomass index for commercial sizes (30+ cm) increased in both 2012 and 2013 (Figure 15). This increase was primarily in the 30-40 cm length interval, which is consistent with an increase in biomass due to the recruitment of this strong year-class. However, no sustained increase is evident in the sentinel biomass index, which increased in 2012 but decreased in 2013 (Figure 16). The

biomass indices for this stock are quite noisy and additional years of data are needed to confirm whether stock biomass is recovering.

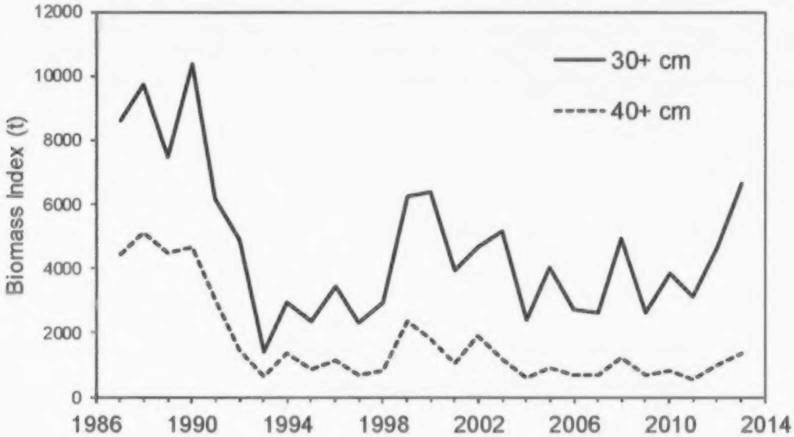

Figure 15. RV biomass index (trawlable biomass, t) for two size groups of witch flounder.

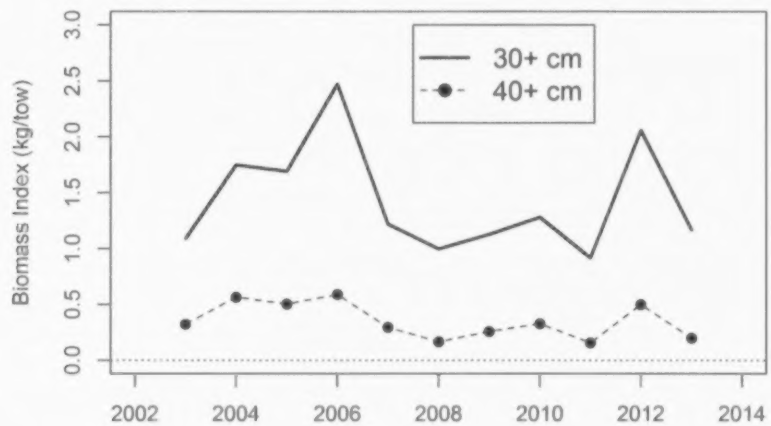

Figure 16. Sentinel survey biomass index for two size groups of witch flounder.

Conclusions

The RV and sentinel biomass indices for pre-commercial and commercial sizes of Atlantic cod, American plaice, white hake and winter flounder in recent years indicate that there has been no improvement in biomass for these stocks since their last assessment. In all cases, the indices indicate that commercial biomass remains at record low levels.

In the case of yellowtail flounder, indices of commercial biomass have declined greatly since the last assessment in 2002. These declines have occurred despite relatively high biomass at pre-commercial sizes, suggesting that mortality at commercial sizes must be very high. The decline in commercial biomass was particularly severe in the strata surrounding the Magdalen Islands, where the main fishery for this stock occurs. In this area, the index dropped suddenly to the lowest level on record in 2007 and has remained at that very low level since then.

In the case of witch flounder, there may have been some improvement in biomass since the last assessment, which used data up to 2011. This improvement appears to reflect the recruitment

of a strong-year class to commercial sizes. However, indices for this stock are quite noisy relative to the signal in the data, and additional years of data are required to substantiate the apparent increase in biomass at commercial sizes.

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Sources of information

This Science Response Report results from the Science Response Process of February 28, 2014, on the review of indices of abundance to 2013 for stocks of six groundfish species assessed by DFO Gulf Region. Additional publications from this process will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

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